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Lodgepole pine and the potential pulp industry in Montana

Byron Lee Foreman
The University of Montana

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and the

POTENTIAL PULP INDUSTRY

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Byron L. Foreman
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Approved:

Chairman of Board
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Dean, Graduate School

ProQuest LLC.
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CHAPTER I

THE PROBLEM AND ITS IMPORTANCE

There exists in Montana a large quantity of lodgepole pine (Pinus contorta var. latifolia Engelm.) which is not being fully utilized at the present time. The possibility of utilizing this timber resource of Montana for the production of paper pulp[1] will be considered in this paper.

THE PROBLEM

It was the purpose of this study, (a) to investigate the suitability of lodgepole pine as a source of wood from which to manufacture paper pulp; (b) to investigate some areas in the lodgepole pine region of Montana for the establishment of a pulp mill.

IMPORTANCE OF THE PROBLEM

An increasing consumption of paper pulp combined with a depletion of timber resources are causing a pulpwood[2] procurement problem in the United States.

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[1] Paper pulp or pulp is used in this study to mean a material manufactured from wood which is used in making paper and related products. The various types of pulps are described in Chapter II.

[2] Pulpwood is any wood which is used in making pulp.

World pulpwood outlook. The world's pulpwood supply may serve to emphasize the national situation. The recent conference on world pulp problems, held by the Food and Agriculture Organization of the United Nations, was in unanimous agreement that no pulp factory should be built without being assured of a continuous supply of raw materials based on sustained forest yield. The only areas of the world which could increase pulpwood production without seriously depleting their forests are North America and the U.S.S.R. (14)

National pulpwood supply. By 1946, many of the manufacturing plants in the older pulp and paper producing regions of the United States faced a major timber supply problem resulting from overconcentration. In the New England, Middle Atlantic, and Lake states the supply of suitable raw material was inadequate to meet the demands. Even in the South and the Pacific Northwest, the supply of suitable species was becoming critical due to overconcentration and competition with other timber using industries. (5)

The United States Forest Service has estimated that the pulp requirements for 1950-1955 will call for five million additional cords[3] of pulpwood annually over that

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[3] A cord is the amount of wood contained in a stack which is four feet high, four feet wide and eight feet long. The cubic feet of solid wood in a cord varies from eighty to one hundred cubic feet.

amount cut during the peak year of 1944. (11) This represents a 35 per cent increase in raw material consumption. An estimated seventeen million tons of pulp may be needed in 1955 for paper making alone. (6) This compares to a total production of twelve million tons of pulp in 1947. (2)

The United States is and has been cutting more timber of saw-timber size than is being replaced by growth. At present, 70.2 per cent of the pulpwood cut in the United States is obtained from trees of saw-timber size.[4] (11) Any utilization of lodgepole pine which may be accomplished will probably include a larger percentage of small sized material and would, in addition, relieve some of the drain on more heavily exploited species.

Local pulpwood supply. In the wood supply economy of Montana, the increased use of lodgepole pine would be even more desirable. The Northern Rocky Mountain Forest and Range Experiment Station of the United States Forest Service has estimated that the present allowable annual cut of lodgepole pine in Montana is 155,000 M.b.f.[5] of which only 27,000 M.b.f.

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[4] Saw-timber refers to trees of sufficient size to produce lumber. This size varies with different species and in different parts of the country.

[5] In this study, the standard abbreviation of M.b.f. is used to represent, "thousand board feet log measure." The conversion factor of two cords per M.b.f. is used. (7)

are being cut annually. (9) With the application of elementary principles of silviculture made financially advisable by a market for lodgepole pine, the response of this species in growth rate would give higher future yields. Other advantages to local economy will be considered in the discussion of pulp mill establishment in Chapter V.

SOURCES OF INFORMATION

The referenced and quoted material in this study was obtained from books, pamphlets, and other publications. Some information was also obtained from personal interviews and the personal correspondence of the author. A list of these sources of information is contained in the bibliography.

CHAPTER II

PRESENT PULPING METHODS

A brief discussion of the most common methods of pulping and the types of pulps produced by them will help to determine the possibilities of the use of lodgepole pine.

THE SULPHATE PROCESS

The sulphate or kraft process of pulping is a chemical process which has been used principally in the conversion of jack pine (Pinus banksiana Lamb.), and the southern pines. About 45 per cent of the wood pulp produced in the United States in 1947 was sulphate pulp, which accounted for about 49 per cent of the total pulpwood consumption for that year. (2)

This is an alkaline method of pulping. The active chemicals used are caustic soda and sodium sulphide. Wood chips are cooked in a solution of these chemicals. The lignin and other binding materials are removed with the cooking liquor, leaving only the wood fibers which are used in making the paper. The process received its name because of the use of sodium sulphate in renovating the cooking liquor and can be used in the conversion of almost any wood. Most sulphate pulp has been bleached when needed for making newsprint and high quality papers and boards. In 1947, 20.6 per cent of the sulphate pulp produced in the United States was bleached. (2)

sulphate pulp produced in the United States was bleached. (2)

THE SULPHITE PROCESS

The sulphite method, (sometimes spelled sulfite), is also a chemical method of conversion of wood to pulp. This process has been used mainly with such species as the spruces, firs, and hemlocks. In 1947, 23.2 per cent of the wood pulp produced in the United States was sulphite pulp. (2)

The most common technique used in the sulphite process is to cook the wood, in the form of chips, in a solution of calcium bisulphite and sulphurous acid. A yield of about 45 per cent pulp by weight of original wood is obtained. Other methods developed recently have been: (a) the use of ammonia base sulphite acid; (b) the use of sodium base sulphite acid; and (c) the use of magnesium base sulphite acid cooking liquors. (29) Most of the sulphite pulp produced is bleached and used in the manufacture of book paper, newsprint, bonds, tissues and other high quality papers.

THE GROUNDWOOD PROCESS

The groundwood process is a mechanical method of pulping wood. The barked wood is ground on a grindstone which has been especially dressed to give a grinding action. The yield of pulp is approximately 90 per cent based on the raw wood weight. The pulp is inferior and is usually mixed with a

longer and stronger fibered pulp such as sulphite pulp or sulphate pulp. The pulp is usually manufactured into newsprint, groundwood papers, or some types of wallboards. Many woods can be used in the groundwood process but the lighter colored, long fibered species produce better pulp. The power consumed in grinding the wood is an important factor in this process.

THE SODA PROCESS AND MINOR PROCESSES

The soda process is a chemical process which is used for the reduction of short fibered hardwoods. The pulp is bleached to a high degree of whiteness and is used in the manufacture of book-paper and envelopes, usually in mixture with some long fibered pulp.

There are several semi-chemical processes. These consist of partial digestion of the chips with one of the chemical liquors and then grinding the softened chips mechanically. Yields up to 80 per cent are obtained and the pulp is used in coarse paper and board manufacture.

CHAPTER III

PREVIOUS INVESTIGATIONS IN USING MONTANA LODGEPOLE PINE AS A PULP SPECIES

Up to the time of the wood shortage of the last war, there was little thought given to the establishment of pulp or paper mills using lodgepole pine in Montana. Before that time, the only investigations were concerned mainly with the use of other species.

In 1920, the United States Forest Service made an investigation as to the possibilities for the establishment of a pulp and paper industry in the Flathead region of Montana. It was the purpose of the Forest Service to offer large blocks of timber for sale as an inducement to a potential pulp mill. Of the stands considered in this proposed scale, only 5 per cent were lodgepole pine. Engelmann spruce (Picea engelmanni (Parry) Engelm.), and alpine fir (Abies lasiocarpa Nutt.) made up 70 per cent of the stands involved. The timber that the Forest Service offered for sale was estimated to contain about 540,000 M.b.f., 63 per cent of which was made up of desirable pulp species. The stumpage price asked on the pulp species was $.50 to $1.00 per M.b.f. Logging cost was estimated at $12.28, per M.b.f. (10) However, no one took advantage of this opportunity.

The Inland Empire Paper Company of Millwood, Washington

has made experimental runs of lodgepole pine from time to time during the last thirty years. These tests were made in their sulphite pulp mill. Most of the tests were made in times of wood shortages such as were experienced during the two wars. The lodgepole pine did not prove satisfactory in these tests. (24)

In 1941, a study of the pulp and paper mill possibilities in the northern Rocky Mountain area was made by E. F. Rapraeger (13) of the Northern Rocky Mountain Forest and Range Experiment Station. This study was concerned mainly with the use of Engelmann spruce, white heteraphylla (Rafn.) Sarg.) in the making of sulphite pulp. He conceded the possibility of using lodgepole pine in making sulphate pulp, but gave a negative view of the sulphate process in Montana. He concluded that a sulphite pulp mill using spruce, fir, and hemlock was feasible under economic conditions as they were at that time.

During and since World War II, an investigation has been carried on by the Idaho-Montana Pulp and Paper Company. This is a regional group that proposes and is presently promoting the establishment of a sulphate pulp mill in western Montana. This company plans to use several species of trees; however, lodgepole pine will be the major one used. (7)

CHAPTER IV

PREVIOUS EXPERIENCE WITH, AND ADVANTAGES OF, LODGEPOLE PINE AS A SOURCE OF PULPWOOD

Lodgepole pine has been used both commerically and experimentally as pulpwood. An investigation of the results of these tests and uses is contained in this chapter.

SHIPMENT OF LODGEPOLE PINE TO EXISTING MILLS

Shipment in cordwood[1] form. At present the shipment of lodgepole pine to existing mills is the only utilization of this species as pulpwood. An estimated 75,000 cords are being produced annually in Montana as of 1949. (1) Starting with less than five thousand cords in 1943, the shipments had increased to an estimated fifty thousand cords in 1946. (22b) Most of this lodgepole pine pulpwood was cut in the eastern[2] part of Montana and shipped to pulp mills in Wisconsin. Before February, 1947, some lodgepole was shipped east to the

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[1] Cordwood is wood in the form of short bolts, usually around one hundred inches long and measured in cords. An overrun is given to the mill through the addition of two inches to each four feet of length of the bolts.

[2] Eastern Montana as used in this study, means Montana east of the Continental Divide.

Wisconsin mills from western Montana but at that time the freight rate on such shipments was increased from $10.00 to $15.00 per cord. Due to this increase, pulpwood shipments to the east from western Montana were discontinued. (34) Most of the lodgepole pine shipped to Wisconsin was used in the manufacture of sulphate, with a small amount used in the manufacture of sulphite pulp. (21)

Shipment as loose or baled chips. The shipment of loose pulp chips does not seem to be an economical procedure. A carload of loose, gravity settled pulp chips contains 40 per cent less solid wood than the same car filled with solid pulpwood. (13) Thus the shipping costs, already a limiting factor, would be increased.

The shipment of hydraulically baled chips offers better possibilities. Baled chips might be equal in volume of solid wood per carload to cordwood. Due to the cost of baling, this method would be economically advisable only if large volumes of waste material which could not be shipped otherwise were available. (13) Neither of these methods have been used in the past and since no large volumes of lodgepole pine are available in a waste form, this method of utilization will not be considered further.

SUITABILITY OF LODGEPOLE PINE IN THE VARIOUS PULPING PROCESSES

The sulphate process. Lodgepole pine has proven very satisfactory for the sulphate process. The best evidence of its suitability for this method of pulping is the price that is being paid for lodgepole pine by mills in Wisconsin. At the present time the average price per cord delivered to Wisconsin mills is $30.00 (26). This compares to an average of $23.10 per cord paid for all pulpwood in Wisconsin in 1947. (2)

Numerous experiments on the sulphate pulping of lodgepole pine have been carried out. (21,27,28) These tests have shown that a satisfactory sulphate pulp is obtained from lodgepole pine. In comparative tests using spruce pulp as a standard, lodgepole pine pulp has been equal in strength and in bleaching qualities. Sulphate pulp from lodgepole pine is suitable for all the types of papers and boards for which sulphate pulp is normally used.

Engelmann spruce and Douglas-fir (Pseudotsuga taxifolia (Lamb) Brit.), are also suitable for sulphate pulping and the availability of these species will be considered in determining the possible locations of pulp mills.

The sulphite process. The sulphite pulping of lodgepole pine is more difficult than sulphate pulping. The Forest

Products Laboratory of the United States Forest Service at Madison, Wisconsin has done considerable experimental pulping of lodgepole pine by the sulphite method.

The results of tests made in 1925 by the Forest Products Laboratory indicated that lodgepole pine was suitable for pulping by the sulphite method. The results of these tests are summarized as follows:

Conversion	:	Reduces readily.
Unbleached pulp	:	Excellent color, fine fibred, very strong, sometimes somewhat pitchy; easily bleached. Yields 45 to 50 per cent.
Bleach needed	:	10 to 20 per cent.
Uses of pulp	:	News, wrapping, book and high-grade printing papers.[3]

Further experiments were made during 1949 at the Forest Products Laboratory. Easily bleaching sulphite pulp was made with satisfactorily low screening rejects. The unbleached pulps, however, contained considerable amounts of dark fiber bundles, which were readily bleached. The strength of the pulp was somewhat less than that of spruce sulphite pulp. The pulps had ether-solubility values sufficiently high to indicate the possibility of pitch troubles. (28)

The Inland Empire Paper Company, a sulphite mill, concluded that the pitch in the lodgepole pine tested would cause trouble. The pitch, while seemingly of no greater

[3] Wells, Sidney D. and Rue, John D. The suitability of American woods for paper pulp. U.S. Department of Agriculture Bulletin 1485. 1927

volume than in Engelmann spruce, does not come out of the pulp as it does in the use of the sulphite pulp woods. (24)

In determining the most suitable type of sulphite cooking liquor, the Forest Products Laboratory concluded that the usual calcium base sulfite process would be fairly satisfactory for lodgepole pine. Better pulping would probably be obtained by the use of a soluble base sulphite acid, such as sodium or ammonia base acids. Two companies in the United States are using ammonia base acid in pulping. These are; Rayonier Incorporated of Shelton, Washington, and The Eastern Corporation of Bangor, Maine. There are no American mills using sodium base sulfite acid. (29)

The Consolidated Water Power and Paper Company of Wisconsin Rapids, Wisconsin, has done some sulphite pulping of lodgepole pine in their sulphite mill. They found that lodgepole pine was cooked with good success. The strength of the pulp was on a par with spruce sulphite pulp. The pulp was bleached to a high brightness with a lower chlorine consumption than for regular sulphite pulp from other coniferous woods. Screenings were roughly twice as great as for spruce. The pitch content of the unbleached pulp was rather high. (31)

Although in some ways lodgepole pine would seem to be suitable for sulphite pulping, there are indications that some

trouble is to be expected from pitch. Pitch present in pulps may interfere seriously with the operation of the paper machine and also lower the quality of the paper. Extensive paper-making trials and investigations of ways to get around the possible pitch troubles would be needed however, before the production costs, as affected by pitch, could be determined. (30)

Douglas-fir is unsatisfactorily pulped by the sulphite process. (29) This fact will be an important consideration in the determination of the type of pulp mill to establish since Douglas-fir is the principle associate species of lodgepole pine in Montana.

The groundwood process. In 1947, the Forest Products Laboratory conducted some grinding tests on green-cut and standing dead lodgepole pine from Montana. Results of these tests indicated that pulps of good strength could be produced at moderate energy consumption from either the dead or green lodgepole pine. The green wood produced slightly better pulp than the dead wood. The energy consumption had about the same range as the power requirements of spruce. The pulps prepared from the lodgepole pine had higher average strength than the average of a number of commercial newsprint grade groundwood pulps. (15)

The Consolidated Water Power and Paper Company concluded, from tests on the groundwood pulping of lodgepole pine, that it compared well with spruce. The strength and power consumption in grinding were equal to spruce, although the brightness was a little lower. (31)

PHYSICAL CHARACTERISTICS OF LODGEPOLE PINE COMMON TO ALL PULPING METHODS

Lodgepole pine has several characteristics which increase its value as pulpwood for any of the pulping processes. Montana lodgepole pine has a smooth straight form which makes it possible to get ninety-six to ninety-seven cubic feet of solid wood in a cord, as compared to eighty-seven cubic feet of solid wood in a cord of Wisconsin jack pine, a common pulpwood species. (1) Lodgepole pine has a relatively thin bark which makes it more suitable for pulpwood. (23)

The length of the fibers of lodgepole pine are about the same as that of jack pine. (21) The diameter of the fibers of lodgepole pine however, are greater than those of jack pine. This is a desirable paper making quality. The Thilmany Paper Company of Kaukauna, Wisconsin, has taken advantage of this greater diameter, which increases the toughness of the pulp, in the manufacture of a glassine paper. This paper is subjected to a polishing process in

in which the fibers of lodgepole pine have stood up better than jack pine. (23)

Another advantage of lodgepole pine has been the success in pulping dead trees. A number of pulp companies are accepting up to 40 per cent dead material in their pulpwood. (22) Results of tests conducted at the Forest Products Laboratory showed a greater yield for the dead wood than the green wood; approximately 44 per cent of the dry weight for the dead wood compared to 42 per cent for the green wood. There was small loss in the strength properities of the dead wood even where a relatively high percentage of decay was present. Test material containing as much as 28 per cent of advanced decay still possessed 88 per cent of the bursting, 98 per cent of tearing, 92 per cent of the tensile and 95 per cent of the folding strength of that of green-cut wood. (20)

CHAPTER V

THE ADVANTAGES IN USING LODGEPOLE PINE AS A PULPWOOD LOCALLY RATHER THAN AS A RAW MATERIAL FOR EXPORT

Since there are large amounts of lodgepole pine being shipped to Wisconsin mills at present, it must be determined whether this is the best method of utilization as compared to the establishment of a local pulp mill.

PULPWOOD EXPORT

At the present time the average price paid for lodgepole pine delivered at the mill in Wisconsin is $30.00 per cord. (26) The cost of transportation by rail from eastern Montana to these mills is $14.25 per cord. (25) This leaves about $15.75 for stumpage, logging costs and profit. The 75,000 cords shipped last year indicates that there is a sufficient margin for stumpage and profit at this price.

In 1947, the average delivered price for pulpwood in the United States was $17.83 per cord. The average delivered price for pulpwood in Wisconsin was $23.10 in the same year. (2) These figures may not be compared directly to the $30.00 presently received for lodgepole pine because of the different years involved; however, 1947 was not a low price year for pulpwood and some comparisons may be made. It can be seen that

$30.00 per cord is a marginal price for the Wisconsin Mills and it is questionable how long they can afford to pay that much.

A freight rate which nearly equals the average delivered price for pulpwood in the United States will limit the amount of lodgepole pine used by the Wisconsin mills. The Consolidated Water Power and Paper Company has used only a small amount of lodgepole pine because of the high transportation costs. (31)

ADVANTAGES OF LOCAL UTILIZATION

The pulp industry. The shipment of pulpwood does not offer the advantages to the local economy that a pulp industry does. Besides the general increase in prosperity that any industry brings to an area, a pulp mill offers other advantages.

A pulp mill provides employment in considerable quantity. A one hundred ton pulp mill[1] would require the services of approximately three hundred employees, including those engaged in the logging. (13)

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[1] In the discussion of pulp mill establishment, a one hundred ton pulp mill will be used as a standard and means that one hundred tons of pulp are produced daily. This is the smallest unit normally considered economical.

A pulp mill also offers regularity of employment since the nature of the technical operations are such that it does not pay to run the mill at intervals. (13) Due to the large investment and the size of the establishment necessary to produce pulp, there is more permanency to a pulp operation than most wood-using industries.

Pulp manufacture utilizes the timber more completely than any other large-scale method of timber utilization. On most timber growing sites in Montana there is not much hope for practicing intensive forestry as a commercial undertaking unless a pulp industry is present to utilize the smaller sized material. (13)

In the management of many of the timber stands of Montana for the production of saw-timber, a higher degree of management could be accomplished at a lower cost if a market were available for the smaller trees. A pulp mill would furnish this market.

The paper industry. The question of the advisability of establishing an integrated pulp and paper mill in Montana will not be included in this study. The marketing of a paper product is a complex economic problem. However, there are indications, based on transportation costs alone, that a paper product could be marketed in competition with other producing areas. With most types of paper a considerable

amount of cross shipment occurs between producing regions, indicating that transportation costs are not a limiting factor. The Pacific coast ships newsprint by rail to the Rocky Mountain region and Canada ships newsprint to all parts of the United States chiefly by rail. (6)

In comparing pulp mills with integrated pulp and paper mills there are two factors that are significant. Freight rates in general have been lower on pulp than on paper because of the lower value of pulp and the larger tonnages per railroad car when shipping pulp. Secondly, in the Pacific Northwest, profits have been greater for pulp mills than for integrated mills. (6)

For these reasons, this report will consider only the problems of pulp mill establishment. At any rate, a pulp mill would be necessary before the question of paper mill establishment would be important.

CHAPTER VI

DETERMINATION OF THE TYPE OF PULP MILL TO ESTABLISH

Before considering the problems of establishing a pulp mill in Montana, the type of pulp which would be produced must be determined.

A GROUNDWOOD PULP MILL

Lodgepole pine is suitable for the making of groundwood pulp. However, groundwood pulp is only about half as valuable as the other types. (2) This definitely limits the distance to which groundwood pulp can be shipped. Even if the pulp were converted locally in an integrated mill, the resultant newsprint and groundwood papers made from groundwood pulp are relatively low in value, thus limiting the distance to which the paper products could be shipped. Most of the groundwood pulp produced in this country is made in integrated mills that are located close to the centers of population. (13)

The best prospect for expansion of newsprint production seems to rest with Canadian mills. Canada has large supplies of cheap wood and, because of the United States tariff on other types of papers, mills in Canada cannot readily shift to the production of other paper grades.(6)

A SULPHITE PULP MILL

As shown previously, lodgepole pine has proven fairly satisfactory as a pulpwood species for the sulphite process. The greatest shortage of timber in the United States has been in species which are suitable for sulphite pulp. However, since there are production problems relating to the elimination of pitch in lodgepole pine pulp which have not been solved at the present time, it would be of no importance to discuss the present utilization by this method.

The remainder of the discussion will therefore, be concerned with the sulphate process; however, if the sulphite method are solved in the future, it will probably be the most advantegeous type of mill to establish. The main conditions that would determine whether or not it were economically advisable to establish a sulphate mill would also govern the establishment of a sulphite mill.

A SULPHATE MILL

Lodgepole pine and the Douglas-fir and Engelmann spruce that occur with it in Montana are all suitable for the manufacture of sulphate pulp. The competitive status and problems of a sulphate mill will be taken up in Chapter VII, but there are several factors that point to the superiority of a sulphate pulp mill for Montana.

The market demand for sulphate pulp has been such that its price has, in some years, compared favorably with that of sulphite pulp. In 1947, bleached sulphate pulp was sold for an average of $145.30 per ton compared to an average price of $125.36 per ton for bleached sulphite. (2)

The average cost of producing sulphate pulp has been lower than the cost of producing sulphite pulp in the same producing regions. The average cost of producing unbleached sulphate pulp in the Lake States and the Pacific Northwest in 1946 was $50.69 per ton. The average cost of producing unbleached sulphite pulp in 1946 in the same regions was $55.33. This relationship has held since 1930, when the sulphate method of pulping came into general use. (6)

The amount of sulphate pulp being bleached has increased greatly in recent years. (6) This indicates the wider use to which bleached sulphate pulp is being put, replacing the scarcer sulphite pulp. The principle defect as a printing paper has been overcome with the development of a satisfactory bleaching process. Sulphate pulp is now being used for many types of papers which previously were made from sulphite pulp.

CHAPTER VII

THE COMPETITIVE POSITION OF A SULPHATE PULP MILL IN MONTANA

If a pulp mill is to be established in Montana and the resulting advantages gained by the local and national economy, then there must be an opportunity for profit to the investors in such a mill. Since actual production costs were not determined in this study, some comparisons with existing producing regions will be made.

WOOD COSTS

The major consideration for continuing production of pulp is the wood supply and its availability. In the competitive production of pulp, comparative wood costs are the most important factor to long-run success or failure as mills or areas with low cost wood have an overwhelming production advantage. (6) Regional differences in pulpwood costs are primarily a reflection of the relative scarcity of wood suitable for pulping. Figures on supply to be given in this study[1] demonstrate the natural advantages of quantity and accessibility of wood that could be gained by a pulp mill located in Montana.

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[1] Chapter VIII, The Local Wood Supply Available for a Pulp Mill.

TRANSPORTATION COSTS

The pulp produced in a Montana mill, will, of necessity be shipped long distances and transportation will be a large proportion of the costs involved.

The most important development in the transportation problem of a prospective Montana pulp mill has been the great relative rise in water rates as against rail rates in pulp shipment. As a result, the prewar relationship between rail and water movements of pulp and paper has not been resumed. A much smaller percentage of the total tonnage of pulp than formerly moves by water from the proportion goes by rail. If the present relationship between rail and water rates continues, the advantage of tidewater sites would be materially reduced, and a considerable incentive would be provided to establish pulp mills in the Rocky Mountain States. (6)

Assuming that an equitable freight rate would be obtained on pulp produced in Montana, it is obvious that if Oregon and Washington mills[2] continue to ship pulp by rail through the Rocky Mountain area, a transportation advantage might be attained by a mill in Montana.

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[2] Oregon and Washington mills produced 59 per cent of all domestic pulp sold in the United States in 1948. (6)

A sulphate mill in Montana would also be in competition with the Southern States where the greatest amount of sulphate pulp is produced. The sulphate pulp produced for market shipment by the South is transported by water to North Atlantic and New England States and by rail to the Central and Lake States. (6) Some portions of this market, such as Wisconsin and Minnesota, are nearer to Montana than to the South, and were an equitable freight rate established, a Montana mill would meet Southern competition.

The general competitive position of a Montana pulp mill with Southern mills might be shown by some comparisons. Profits on sulphate pulp have been appreciably higher on the West Coast than in the South. (6) This is true even though the distance from markets is greater for the West Coast mills and may be explained by the lower production costs on the West Coast. West Coast and Southern mills have made considerably greater profits in the manufacture of sulphate pulp than have mills in the Northeast or Lake States. (6)

PRODUCTION COSTS

The competitive position of a Montana mill would also depend on production costs. The obvious factors of wages and cost of raw materials are not necessarily the deciding factors. The Pacific Coast has attained a lower production cost per ton of pulp than the South in spite of higher wages

and costs of raw materials. This low cost has been attained through the use of improved machinery and the greater efficiency of labor. (6) The competitive position of a Montana pulp mill would depend on the efficiency attained in production.

MARKETS

The future market for sulphate pulp appears to be good. Several companies on the West Coast are in various stages of planning or construction of sulphate mills. (12) It is expected that shipments of sulphate pulp from the West Coast will increase. (6)

Expansion of markets. The realized and projected expansion plans show that the need for and ability to produce more pulp in the United States are likely to continue strong. The largest increases are expected for sulphate pulp and paperboard. The present expansion plans for the production of pulp in the United States will be insufficient to balance the added requirements for paper production. (6)

Reduction of imports. In 1948 our imports of unbleached sulphate were 7 per cent of requirements. Imports of bleached sulphate constituted 21 per cent of total consumption. Canada supplied the largest proportion of bleached sulphate and Sweden furnished the largest proportion of

unbleached sulphate. Norway and Finland also exported sulphate pulp to the United States.

It is expected that our imports from Europe will decrease due to decreasing wood supplies and increasing consumption in Europe. (6, 12) The World Pulp Conference of 1949 estimated that Europe would have a deficit of pulp by 1955. (14) Although imports from Canada are expected to remain fairly constant, the decrease of imports from Europe may further develop the market for domestically produced pulp. (12)

The middle western states of Wisconsin, Minnesota, Michigan, Illinois, Indiana, and Ohio had 206 paper mills operating in 1940. One hundred and fifty of these paper mills purchase all of their pulp and these are potential customers for a Montana pulp mill. (17)

It is expected that the future price for pulp in the United States will increase due to a declining wood supply. (12)

CHAPTER VIII

THE LOCAL WOOD SUPPLY AVAILABLE FOR A PULP MILL

Since the wood supply is the most important consideration in the establishment of a pulp mill it is necessary to determine where a sufficient supply exists in Montana.

COMPARISON OF EASTERN AND WESTERN MONTANA

The largest amount and also the greatest concentrations of lodgepole pine in Montana occur east of the Continental Divide. Eastern Montana is also nearer to the markets. In establishing a freight rate for pulp produced in Montana, some differential may be made at the vicinity of the Continental Divide, as has been done on shipment of pulpwood.

Another advantage that the eastern stands of lodgepole pine have as a continuing source of pulpwood supply is that most of the sawmills in Montana, both large and small, are located in the western part of the state. These mills contribute an additional drain on lodgepole pine as a source of lumber, ties, and poles. Although these mills are not utilizing much lodgepole pine at the present time, it is possible that with the depletion of ponderosa pine (Pinus ponderosa Doug.), western larch (Lavix occidentalis Nutt.), and western white pine (Pinus monticola Doug.), increased

cutting of lodgepole pine may take place.

Table I indicates how the supplies of all species, including those that could be used for pulp, compare in eastern and western Montana.

Present drains on the supplies, through cutting, show the comparatively small utilization of, and competition for, the species of primary interest to a potential pulp mill in eastern Montana. In comparison, there is a relatively complete utilization of timber in western Montana, amounting to overcutting of some species.

WOOD SUPPLY BY COUNTIES

Table II and Figure 1 show the volume of standing timber for counties in Montana. The quantities shown are the volumes of timber growing on commercial forest land. Commercial forest land is forest land bearing timber of commercial character economically available now or prospectively for commercial use and not withdrawn from such use.

TABLE I

ALLOWABLE ANNUAL CUT AND
ACTUAL ANNUAL CUT IN MONTANA 1946 (7)

Species	Montana west of Continental Divide		Montana east of Continental Divide	
	Allowable	Actual	Allowable	Actual
Whitepine	15[1]	20	--	--
Ponderosa pine	100	115	25	10
Larch	130	100	--	--
Douglas-fir	105	55	60	15
Engelmann spruce	55	15	20	2
Hemlock	2	2	--	--
True firs	9	½	3	ng
Western redcedar	4	4	--	--
Lodgepole pine	35	2	120	25
Other	5	3	5	3
Total	460	316½	233	55

[1] Volumes are million board feet, log scale, annually.

TABLE II

TIMBER VOLUME ON COMMERCIAL FOREST LAND BY SPECIES AND COUNTY IN MONTANA (22a)

Eastern Counties	Lodgepole pine	Douglas-fir	Englemann spruce
Beaverhead	1,090,000[1]	171,000	
Deer Lodge[2]	54,000	16,000	
Silver Bow[2]	126,000	23,900	
Madison	290,000	140,000	
Gallatin	624,000	144,000	
Park	430,000	181,400	138,200
Sweet Grass	87,400	58,100	44,600
Stillwater	33,400		31,700
Carbon	21,000	13,500	31,000
Meager	350,000	222,000	
Broadwater	89,000	103,000	
Jefferson	304,000	115,000	
Lewis & Clark[2]	258,000	135,000	121,000
Cascade	30,512	25,596	
Judith Basin	42,843	46,879	
Teton	86,000	16,500	25,000
Pondera	19,300		9,650

Western Counties	Lodgepole pine	Douglas-fir	Englemann spruce
Ravalli	39,200	199,200	9,800
Granite	175,000	190,000	10,200
Deer Lodge[2]	13,800	3,700	
Silver Bow[2]	15,900	12,600	
Lewis & Clark[2]	55,000	62,000	
Powell	92,000	199,200	
Missoula	127,500	389,200	
Mineral	27,400	160,300	
Sanders	66,000	232,200	
Lake	38,800	104,300	55,800
Flathead	151,800	461,700	330,700
Lincoln	175,500	552,500	276,000

[1] Figures are thousand cubic feet.

[2] Volumes shown are for portions of the county lying east or west of the Continental Divide.

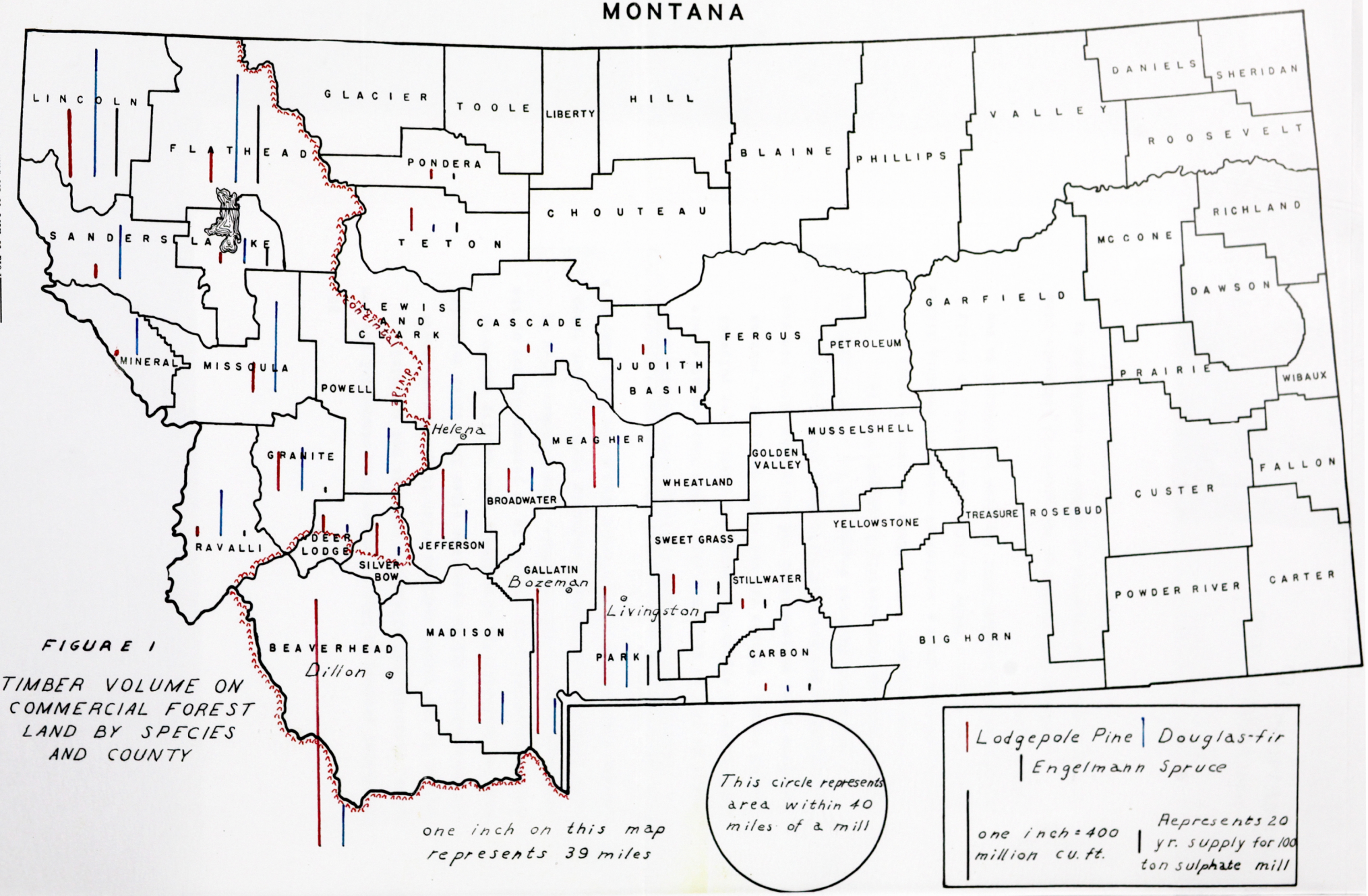

FIGURE 1

TIMBER VOLUME ON COMMERCIAL FOREST LAND BY SPECIES AND COUNTY

The timber growing on land withdrawn from commercial use for parks, reserves, and wilderness areas is not included. Neither is the timber included which is growing on remote and inaccessible alpine areas and other land which owing to very low productivity, excessively poor quality timber or extreme inaccessibility appears to be permanently out of the commercial timber-producing class. The volumes, given in cubic feet, are the volumes, excluding bark, of sound trees and the sound volume of cull trees from a one foot stump to a four inch minimum top diameter.

The volumes are shown for Douglas-fir and Engelmann spruce as well as lodgepole pine. Only those counties are shown where an appreciable volume of these major pulpwood species occur. Volumes are not shown for species such as ponderosa pine, western larch and white pine which are used for sawtimber, but not considered major pulp species.

The annual pulpwood requirment for a one hundred ton sulphate mill is approximately 5,160,000 cubic feet. (7) It is shown in Figure 1 that there are several areas in eastern Montana where a suffieient volume of standing timber is present within a forty or fifty mile radius, to supply a one hundred ton sulphate mill for from one hundred to two hundred years.

Although information on the growth of lodgepole pine is very meager, the reserves of timber are sufficient to

allow for a long rotation before it would be necessary to cut over the same area again. Even under very extensive management, the present supply plus growth would be sufficient to provide a pulp mill with a permanent source of pulpwood within a small radius from the sites selected.

CHAPTER IX

ADDITIONAL BASIC REQUIREMENTS FOR PULP MILL ESTABLISHMENT

Besides the availability of a large supply of wood, there are other requirements which must be met in order to establish a pulp mill. These basic requirements include; (a) water supply; (b) power and fuel; (c) waste disposal; (d) chemicals; (e) labor; (f) transportation; and (g) large investment.

WATER SUPPLY

Large quantities of water are used in the manufacture of sulphate pulp, particularly bleached sulphate pulp. The daily requirements of a one hundred ton bleached sulphate mill might run from two and one-half to four million gallons. (18) The amount of water available at various places in eastern Montana will be shown in Chapter X.

The methods of purification necessary for a mill water supply vary greatly. For some supplies, screening to remove coarse debris, followed by a simple filtration through sand, will make the water satisfactory. (18) The water in the Flathead River could be used without treatment. (17) Although the Flathead River is not located in

eastern Montana, this fact indicates that the specifications are not too exacting for pulp mill water supply.

POWER AND FUEL

Pulp plants require considerable power, and a sulphate mill needs boiler horsepower particularly, for operation of the digesters and steam equipment.

In eastern Montana, the cheapest source of this boiler horsepower would probably be coal from the eastern Montana and northern Wyoming fields. Coal constitutes the greatest known potential mineral resource of Montana. Montana's coal reserves have been estimated to contain about four hundred and sixty billion tons. (19) Most of this coal is not high quality coal but may be obtained at a low price.

Most pulp mills generate a considerable portion of their electrical energy requirements as a by-product of their steam requirements. (32) Some of the electrical energy requirements which were needed could be purchased from the Montana Power Company. (32) The industrial rate of the Montana Power Company is in the low 10 per cent group for the entire United States. Construction is beginning currently on a 66,000 kw steam electric generating plant at Billings, Montana. (32) Also, the Canyon Ferry Dam near Helena will be completed to generate power in approximately two and one-half

years. (35) Any of this power which is not used by cooperatives and municipalities will be available for an industrial consumer.

WASTE DISPOSAL PROBLEM

In establishing a Montana pulp mill consideration must be given to problems of waste disposal, particularly because of recreational values in areas where a mill could be located. Sulphate pulp mill wastes cause a small amount of pollution in marked contrast to the waste disposal problems confronting a sulphite pulp mill.

The Division of Sanitary Engineering in the State Board of Health of Montana has been given the responsibility for control and abatement of stream pollution in the state of Montana. (31) This department has stated that it would require the following of a pulp mill:

> The wastes of a paper pulp mill could not be discharged raw into a stream or river. There would be no objection to discharging pulp mill wastes into a stream providing that adequate treatment of the wastes was accomplished. Plans for a waste disposal system and treatment would have to be submitted to the State Board of Health and their approval for such a waste disposal system obtained. [1]

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[1] Taylor, H. W. Sanitary Engineer, Division of Sanitary Engineering, State Board of Health, Helena, Montana

In a modern sulphate mill the liquid wastes are recovered and either reused in the cooking liquor or burned as a source of energy for other mill processes. This recovery reduces the pollution and also results in a lower consumption of basic chemicals. The portion of the liquid wastes not reused may be converted into by-products, but the heat value of these materials is usually high enough to make it more profitable to burn them for energy. (18)

The recovery of the solid wastes of a sulphate pulp mill is accomplished by the use of filters or sedimentation. The waste disposal problem of a sulphate mill is comparatively simple and inexpensive. (18)

CHEMICALS

The amount of chemicals used in a sulphate mill is relatively small due to the reuse of the cooking liquors after renovation. The recovery of chemicals is over 95 per cent. Sodium sulphate is the chief chemical used in renovating the cooking liquor. Chlorine and sulpher dioxide are used in bleaching.

The sulphate mills in the Pacific Northwest obtain their sodium sulphate, called salt cake, from natural supplies in California. The sulphate mills in the South obtain their sodium sulphate requirements chiefly from Louisiana. The cost of sodium sulphate for a Montana mill would be higher than in these competing regions.

The sulphur dioxide used in bleaching can be obtained from the smelters at Anaconda or Great Falls, Montana. These smelters produce large quantities of sulphur dioxide. Chlorine, also used in bleaching, could probably be manufactured here as cheaply as in other pulp producing regions. (13)

LABOR

It has been mentioned previously that a one hundred ton pulp mill provides direct employment for approximately three hundred people, including the woods labor.

It is anticipated that in an area with a history of logging activity, such as Montana, there would be no difficulty in meeting the skilled manpower requirements necessary in the woods operations supplying a pulp mill. However, since labor within the mill is largely specialized and doing work unfamiliar to the native population, there will be importation of skilled labor to the mill area during the initial years following establishment. This labor will either be assimilated into the native population or replaced by local trainees in a comparatively few years.

To attract and hold a laboring population, and to provide such necessities as stores, churches, schools and recreation on a community level, a town for the mill site should have a population of about five thousand people.

TRANSPORTATION

With respect to main line transportation, eastern Montana is well served in an easterly-westerly direction. The region is traversed easterly-westerly by three important rail lines: The Chicago, Milwaukee, St. Paul and Pacific, the Great Northern and the Northern Pacific. Since the market for pulp will probably be in the Lake States area, these three railroads offer good transportation accommodations.

If a paper product is manufactured in the future, there are rail connections at Butte and Billings, Montana, for shipment to Southern Rocky Mountain and Plains States markets.

LARGE INVESTMENT

A large investment is required to establish a pulp mill. In 1941 about $2,500,000 would have been required for the construction of a one hundred ton bleached sulphite mill. (13)

In 1945 the Idaho-Montana Pulp and Paper Company stated in their prospectus that they planned to raise a net amount of approximately $2,500,000 to construct and put into operation a one hundred ton unbleached sulphite mill and a fifty ton newsprint plant. (4)

A sulphite mill and a sulphate mill are similar in their equipment requirements and it is expected that a bleached sulphate mill would require a similar amount of capital for construction.

CHAPTER X

ACTUAL MILL SITES IN EASTERN MONTANA

In examining the possible sites for a pulp mill in eastern Montana, four cities were selected which were located near concentrations of lodgepole pine stands. These sites are: Helena, Livingston, Bozeman and Dillon.

The volume of lodgepole pine within forty or fifty miles of each of these sites is sufficient to supply a one hundred ton pulp mill for over one hundred years. See Figure 1, page 38. The existing road system and the availability of the stands would determine the cost of the wood at the different sites, at least in the initial years.

The water supply available near these cities is shown in Table III. It was assumed that a pulp mill would have to furnish its own water supply. However, a large part of the water supply of a mill might be obtained from the existing city water supply. In Livingston for example, there would be 4,500,000 gallons a day available from the city water supply, which would be sufficient for a one hundred ton bleached sulphate mill.

These cities are all of sufficient size to accommodate the labor supply of a mill. Helena, Livingston and Bozeman are all located on a main line east-west railroad.

TABLE III

DISCHARGE OF RIVERS NEAR EASTERN MONTANA CITIES (25)

City	River	Annual[2] Discharge	Minimum Discharge
Helena	Missouri	4,960[1]	500
Bozeman	Yellowstone	3,570	590
Livingston	Gallatin	703	130
Dillon	Beaverhead	420	69

[1] Volumes given in cubic foot seconds.

[2] The water requirements of a one hundred ton bleached sulphate mill would be approximately five cubic foot seconds, as one cubic foot second equals 646,316.88 gallons per day.

As is to be expected, these sites all have their relative advantages and disadvantages. Actual production costs in each location were not determined but the minimum essentials of establishment are met in each location.

CHAPTER XI

SUMMARY AND CONCLUSIONS

Due to an increasing consumption of paper products and a diminishing pulpwood supply, a pulpwood procurement problem has developed in the United States. This problem is present in varying degrees in all of the pulp producing regions.

There is a large available supply of lodgepole pine in Montana, especially east of the Continental Divide. The wood supply economy of the United States would benefit if this timber, not fully utilized at present, were used in the manufacture of paper pulp.

A pulp mill located in Montana would benefit the local forest industries and the economy of the communities concerned.

Lodgepole pine has proven to be a satisfactory pulpwood species for making sulphate and groundwood pulp. Some difficulties have been encountered in the manufacture of sulphite pulp from lodgepole pine due to the presence of pitch. However, these difficulties are not insurmountable and it is probable that they will be overcome in the future.

At the present time the manufacture of bleached sulphate pulp seems to offer the best possibilities for the utilization of lodgepole pine in Montana. Bleached sulphate pulp is being used to a greater extent in recent years, replacing sulphite pulp. The consumption of coarse papers and paperboards, which are made from sulphate pulp, has increased to a greater extent than the consumption of other types of paper products. This trend is expected to continue. Due to these facts it is probable that a market could be found for sulphate pulp produced in Montana. This market would be located largely in the Lake States where a large amount of lodgepole pine, in the form of pulpwood, is being shipped at the present time.

Lodgepole pine has several physical characteristics which increase its value as a source of pulpwood for the manufacture of sulphate pulp. The smooth straight form and thin bark of Montana lodgepole pine make possible a high content of solid wood per cord and reduce handling costs.

The large diameter of the fibers of lodgepole pine is a valuable paper-making quality. The success in pulping dead trees would allow utilization of disease and insect killed lodgepole pine.

If equitable freight rates are established and good efficiency is obtained in the production of the pulp, it

would be possible to operate a sulphate pulp mill in Montana at a profit, in competition with other producing regions.

The requirements for the establishment of a sulphate pulp mill are met in the vicinity of each of the following cities of eastern Montana: Helena, Livingston, Bozeman, and Dillon.

There appears to exist an opportunity for establishing a profitable and beneficial industry, a sulphate pulp mill, at one of these locations.

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